AGE, SEX AND LENGTH COMPOSITION OF CHINOOK SALMON FROM THE KUSKOKWIM RIVER SUBSISTENCE FISHERY, 2001

By

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Regional Information Report[1] No. 3A02-33

Alaska Department of Fish and Game
Commercial Fisheries Division
Arctic-Yukon-Kuskokwim Region
333 Raspberry Road, Anchorage, Alaska 99518

September 2002

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SPONSORSHIP

This project was funded by the U.S. Fish and Wildlife Service (USFWS), Federal Office of Subsistence Management (FOSM), through the Fisheries Resource Monitoring Program and is in partial fulfillment of grant numbers FIS 01-132, FIS 01-225 and FIS 01-023. FOSM provided $358,000 in funding for these three projects over a three-year period. Funding for these projects supports chinook salmon age-sex-length sampling and inseason harvest surveys. Additional funding support was provided through FIS 01-117 and the State of Alaska.

The Bethel area inseason subsistence salmon harvest data collection, grant number FIS 01-132, was designed as a cooperative project between the Alaska Department of Fish and Game (ADF&G) and Orutsararmiut Native Council (ONC). The middle Kuskokwim River inseason subsistence salmon harvest data collection, grant number FIS 01-225, was designed as a cooperative project between ADF&G and Kuskokwim Native Association (KNA). The upper Kuskokwim River inseason subsistence salmon harvest data collection, grant number FIS 01-023 was designed as a cooperative project between ADF&G and McGrath Native Village Council (MNVC).

ACKNOWLEDGMENTS

Moses Anvil Jr., Byron Dull, Rachel Chamberlain, Dwayne Hoffman and Tassy Olsen solicited samplers to collect ASL data for chinook salmon in the Kuskokwim River subsistence fishery. Dave Folleti assisted in the processing of these data. Mike Coffing (ADF&G/SD) coordinated subsistence harvest data collecting and reporting. Linda Brannian and Susan McNeil provided draft review of this report. We thank all the samplers and fishers in the Kuskokwim River that participated in collecting ASL data from chinook salmon.

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ABSTRACT

Age-sex-length (ASL) data were collected from chinook salmon harvested during the 2001 Kuskokwim River subsistence fishery to characterize the ASL composition of the total annual subsistence harvest from the lower, middle and upper Kuskokwim River. Four organizations were involved in coordinating these data collections: Alaska Department of Fish and Game, Orutsararmiut Native Council, Kuskokwim Native Association and McGrath Native Village Council. Most of the fish were sampled by twenty local community members who were provided with sampling kits and trained in standard sampling procedures. The information collected for each fish included scales used for age determination, length, sex that was confirmed through internal examination of gonads, date and location of capture, and gear type. A total of 1,170 chinook salmon were sampled: 1,010 fish from the lower Kuskokwim River, 130 fish from the middle Kuskokwim River, and 30 fish from the upper Kuskokwim River. Samples were collected from a variety of gear types, but most of the fish were caught in gillnets with a mesh size 8 inches or larger. The overall age class composition was dominated by age-1.4 chinook salmon (60.6%). The overall sex composition was 35.4% females. Comparisons among three gillnet mesh size ranges showed the proportion of female chinook salmon increased with increasing mesh size.

KEY WORDS: age-sex-length data, ASL, chinook salmon, Kuskokwim River, subsistence fishery, age class composition, sex composition, gillnet, mesh size

INTRODUCTION

The Kuskokwim River subsistence salmon fishery is one of the largest subsistence fisheries in Alaska, with average annual harvests of 87,000 chinook salmon *Oncorhynchus tshawytscha*, 78,000 chum salmon *O. keta*, 41,000 sockeye salmon *O. nerka*, and 38,000 coho salmon *O. kisutch* (Burkey et al. 2001). The average number of chinook salmon harvested in the subsistence fishery exceeds that of the incidental commercial fishery. Chinook salmon are of particular interest because of the importance of this species as a human food source, the different types of gear used for harvest and the broad range of size and age at return.

Assessment of the age, sex and length (ASL) composition of the total chinook salmon run to the Kuskokwim River includes three major components, the ASL compositions of the incidental commercial harvest, subsistence harvest, and escapement. Each of these components has a unique ASL composition because of the selectivity of gear types used to harvest the chinook salmon. Fishery managers typically collect harvest and escapement ASL data from returning salmon. These samples form the basis for determining spawner-recruit relationships and forecast models. Collecting ASL data from the commercial harvests and escapement-monitoring projects has been a regular part of programs operated by the Alaska Department of Fish and Game (ADF&G) in the Kuskokwim Area. Until 2001, however, no dedicated program existed for collecting ASL data from the subsistence chinook salmon harvest. Staff from ADF&G once estimated the ASL composition of the subsistence harvest by assuming it was similar to the commercial harvest, but this assumption was invalid because different harvest gear types are biased for different size and age of chinook salmon (DuBois and Molyneaux 2000). In the subsistence chinook salmon fishery, any mesh size can be used but the commercial salmon fishery is restricted to gillnets of six-inch or smaller mesh (5 AAC 07.310, ADF&G). The ASL composition of the subsistence chinook harvest should be properly characterized because it is an important component of the total Kuskokwim River run assessment.

The objectives of this study are to estimate the ASL composition of the chinook salmon harvested in the lower, middle and upper Kuskokwim River subsistence fisheries.

Background

Subsistence fishing for salmon occurs throughout the 700-mile length of the main stem Kuskokwim River, and in many of the tributary streams. Subsistence fishers generally rely less on coho salmon than on chinook, chum or sockeye salmon because of the poor fish-drying conditions that exist during the late summer when coho salmon enter the Kuskokwim River (Burkey et al. 2000).

Commercial fishing is mostly limited to a 140-mile span of the lower Kuskokwim River, District W1 (Figure 1). The geographic range of the commercial fishery is constricted to this area because fish harvested farther upriver have poorer flesh quality and are not commercially marketable.

Directed commercial fisheries on Kuskokwim River chinook salmon have not been allowed since 1987 under 5AAC 07.365 (ADF&G 2001). The Alaska Board of Fisheries recognized Kuskokwim River chinook salmon as a "stock of concern" in October of 2000. Since 1998, the abundance of adult chinook salmon returning to the Kuskokwim River has been below the level needed to support harvest expectations and escapement needs (Burkey et al. 2000). Escapement goals were generally not achieved in 1998, 1999 and 2000 despite little commercial fishing effort and restrictions imposed on subsistence fishers in 2000. Currently the Kuskokwim River is being managed under a rebuilding plan for chinook as well as chum salmon under 5AAC 07.365 (ADF&G 2001).

By regulation (5AAC 07.365) subsistence fishing is only allowed for four consecutive days per week in the months of June and July for the Kuskokwim River. Subsistence fishing was open Wednesday through Saturday in 2001. The goal of the subsistence-fishing schedule is to increase the quality of chinook and chum salmon escapement (more females) and to spread subsistence harvest opportunity among users throughout the drainage. Salmon may be harvested only by gillnet, beach seine, hook and line attached to a rod or pole, hand line, or fish wheel. The aggregate length of set or drift gillnets may not exceed 50 fathoms. Any mesh size gillnet may be used though, gillnets less than six-inch mesh must be less that 45 meshes deep and nets with greater than six-inch mesh may not be more than 35 meshes in depth. Most fishers use both set and drift gillnets. Probably, much of the chinook salmon harvest is taken with gillnets larger than six-inch mesh.

Data on the subsistence harvest of salmon are collected annually. The Division of Commercial Fisheries began conducting subsistence salmon harvest surveys along the Kuskokwim River in 1960. The Division of Subsistence assumed this responsibility in 1988 (Burkey et al. 2001). Generally, subsistence harvest is estimated from house-to-house surveys of villages along the Kuskokwim River. Village totals are estimated when survey data are expanded to include those not surveyed. Village totals are summed for area and drainage-wide totals. Harvest estimates represent seasonal totals and temporal information is lacking. Harvest by gear type is also unknown.

Study Area

The study area partitions villages and associated fish camps into three geographic sections: the lower Kuskokwim River; which ranges from near the mouth to Tuluksak (river mile (rm) 136); the middle Kuskokwim River which ranges from just below Lower Kalskag (rm 188), to Chuathbaluk (rm 236), and the upper Kuskokwim River which includes all villages upstream of Chuathbaluk (Figure 1). The lower Kuskokwim River is further partitioned into two areas: the Bethel area (Napaskiak (rm 71) to the mouth of the Gweek River (rm 90)), which is where Orutsararmiut Native Council (ONC) coordinated ASL data collections, and the lower Kuskokwim River outside of the boundaries of the Bethel area, which is where ADF&G was responsible for coordinating ASL data collections (Figure 2). Kuskokwim Native Association (KNA) was responsible for coordinating collections of ASL data in the middle Kuskokwim River and McGrath Native Village Council (MNVC) was responsible for the upper Kuskokwim River.

Most of the subsistence harvest was taken from the lower Kuskokwim River. In 2000, the chinook salmon harvested from this section accounted for 83.7% of the total Kuskokwim River subsistence chinook harvest (Burkey et al. 2001). The Bethel area has the highest percentage of subsistence chinook salmon harvested in the Kuskokwim River drainage. In 2000, Bethel households accounted for 35% of the total Kuskokwim River chinook subsistence harvest (Burkey et al. 2001). In contrast, the middle and upper Kuskokwim River accounted for 10.4% and 3.4% of the harvest (Burkey et al. 2001).

METHODS

The coordinating agency (ADFG, ONC, KNA or MNVC) contracted with samplers to collect ASL data from chinook salmon harvested in their respective area. The samplers included actual fishers, household members or someone else from the community. Samplers were paid for the information they provided on each fish which included: three readable scales, sex, length, gear type, mesh size, date and location of capture, and sampler's name. The organization that contracted with the sampler was responsible for payment.

At the start of the season, technicians from ONC, KNA and MNVC attended a training session in Bethel to learn ASL sampling procedures. Staff from Commercial Fisheries and Subsistence Divisions conducted the training. Staff from ADF&G provided additional inseason training to ONC, KNA and MNVC technicians and to subsistence chinook salmon samplers while accompanying the technicians conducting inriver surveys.

A representative from the coordinating agency identified and contacted prospective samplers by telephone, through referrals from village organizations, or when encountered at fish camps along the river. Persons interested in participating in the sampling program were trained to collect ASL data from chinook salmon following ADF&G protocols. The sampler was provided with a sampling kit that included a meter stick, gum cards, wax paper inserts, forceps, data forms, pencil and a clipboard with attached sampling instructions. Staff from one of the coordinating agencies conducted follow-up visits to subsistence samplers to collect and review data for accuracy. Sampling data were delivered to the ADF&G office in Bethel for processing.

Sample Collection

Sample Design

One important objective of this study was to characterize the age, sex, and length of the Kuskokwim River chinook salmon subsistence harvest. Though subsistence harvest estimates represent the season total, fishing for chinook salmon begins in the lower river in late May and extends through mid July in the upper river. Effort and harvest success may vary by week and is unknown. Harvest by gear type is also unknown. By the nature of our collection method we tried to overcome the non-random or non-systematic nature of our sampling by collecting as many ASL samples as possible throughout the month of June. We are conducting what Geiger et al. (1990) termed a "grab sample" in that we lacked the guarantee that each chinook salmon in the harvest had an equal chance of selection (random sample) or that every i^{th} fish would be sampled (systematic sample). For example, harvest occurring in areas without ASL samplers would not be represented in the sample. Gathering of an ASL sample would be very opportunistic and would be tied to availability in time and area of fish and samplers. We assumed that large sample sizes collected in the "grab" sample nature (opportunistic) might represent the harvest by gear and through time. If effort is expanded to collect many samples then the assumption would be that when many fish are available (i.e. harvested) many samples would be collected and therefore be self-weighting by gear and area over the time period samplers are working. This assumption is necessary if samples pooled through time are thought to be representative of the post-season harvest estimate.

The grab sample design (Geiger et al. 1990) was used to sample the Kuskokwim River subsistence chinook fishery during 2001. We collected as many samples as possible, spanning all gear types, from each area. All samplers that were interested were encouraged to participate. The tentative sample goals were 3,000 from the lower Kuskokwim River (2,000 by ONC and 1,000 by ADF&G), 1,500 from the middle Kuskokwim River and 1,000 from the upper Kuskokwim River. Postseason, samples from each area were to be used to apportion the harvest from that area by age and sex.

Sampling Procedures

Sampling methods follow routine procedures outlined by ADF&G protocols (DuBois and Molyneaux 2000). The sampling routine includes the removal of scales from the preferred area of the fish for use in age determination (INPFC 1963). Three scales were removed from each chinook salmon to account for regeneration of freshwater annuli and mounted on gum cards. An instruction sheet attached to a clipboard was provided to each sampler illustrating this procedure (Appendix A.1). Sex was determined by cutting the fish and examining for the presence of eggs. Length was measured to the nearest millimeter from mid-eye to the fork-of-tail using a meter stick. The sampler's name, scale card number, date, location, gear type, mesh size, and fish sex and length were recorded on a write-in-rain data form (Appendix A.2). Also included on the data form was the question – Did you cut every fish to look for eggs? This question was included to verify the sex.

Age Determination

Age is determined from the annuli of scales taken from the preferred area of the fish (INPFC 1963). The scales, which are mounted on gum cards, are impressed in cellulose acetate using methods described by Clutter and Whitesel (1956). The scale impressions are magnified with a microfiche reader and age is determined through visual identification of annuli. Ages are directly entered into the computer ASCII files using European notation[2].

Length information from chinook salmon is helpful in determining ages of absorbed or otherwise questionable scales because chinook salmon have a distinctive range of lengths for each age class (DuBois and Molyneaux 2000). When aging chinook salmon scales, length at age is compared to historic ranges and ages outside of the length range for that age class are noted. When all chinook salmon have been aged, a length frequency histogram is compiled and the questionable ages are reexamined. Some of the questionable ages may be matched to the expected length at age.

Data Processing and Reporting

ASL data collected from the lower, middle and upper Kuskokwim River subsistence chinook harvest were entered into a Juniper[3] field data recorder or directly into a computer ASCII file format. The ASCII files were processed through a number of programs and compiled to produce age-sex and length summary tables. The age-sex table describes the age and sex composition for each stratum as a percentage based on the stratum sample. The length table includes statistics on mean length, standard error and the range of lengths in each age-sex category.

The Kuskokwim River ASL data were spatially stratified by area: lower, middle and upper river. The lower Kuskokwim River ASL data were further stratified by gillnet mesh size ranges: 6-inch or less, 7 ¼ to 7 ¾-inch, or 8-inch and greater. The lower Kuskokwim River ASL data collected from 8-inch and greater gillnets were temporally stratified because the sample dates fit conveniently into weekly strata based on the weekly subsistence-fishing schedule and there were adequate numbers of these samples.

The ASL data collected from the lower, middle and upper Kuskokwim River chinook salmon subsistence fisheries were combined because the sample sizes from the middle and upper Kuskokwim River were inadequate to allocate the subsistence harvests from these areas. The ASL composition from the combined data were applied to the postseason harvest data compiled by Subsistence Division to estimate the ASL composition of all chinook salmon harvested in the Kuskokwim River subsistence fishery.

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[2] In European notation two digits are separated by a decimal and refer to the number of freshwater and marine annuli respectively. The first digit represents the freshwater age minus one. The second digit represents the number of annuli formed during the marine residency. Total age from brood year is the sum of the two ages plus one.

[3] The use of trade names intends only to document the methods used and does not constitute an endorsement by ADF&G.

RESULTS

A total of 20 local community members collected samples from the Kuskokwim River subsistence chinook salmon fishery. All samplers reported on the data form that the sex of all chinook salmon sampled was verified by cutting the fish and looking for eggs. A summary of ASL data collected from chinook salmon during the 2001 subsistence fishery was distributed in March of 2002 to those samplers who participated in data collecting (Appendix A.3).

Lower Kuskokwim River

The sample data collected between the coordinated efforts of ADF&G and ONC were combined for characterizing the ASL composition from chinook salmon sampled in the lower Kuskokwim River. The lower Kuskokwim River samples accounted for 86.8% of all aged samples from the entire Kuskokwim River.

Sample Size

In the lower Kuskokwim River, 18 samplers collected ASL samples from subsistence chinook salmon harvested near the villages of Tuntutuliak, Napakiak, Oscarville, Bethel and Kwethluk (Table 1). In addition, one staff member from ADF&G collected samples. ONC identified and trained 9 samplers in the Bethel area, while ADF&G identified and trained 8 samplers from the villages of Tuntutuliak and Napakiak and the Bethel area. ADF&G subsequently referred four of these Bethel area samplers to ONC to simplify the payment process. ONC paid samplers directly from funds issued directly to ONC from ADF&G, Division of Administration. ADF&G staff gave a training meeting in Kwethluk and distributed sampling kits to interested persons but no samples were submitted.

The 18 lower Kuskokwim River samplers collected ASL data from 1,010 chinook salmon (Table 1). A total of 600 chinook salmon were sampled from the Bethel area and 510 from outside the Bethel area. Only 938 of these samples were included in the age-sex summary because of unreadable scales (Table 2), and 903 samples were included in the length summary because of incomplete data (Table 3).

Gear Types

The chinook salmon sampled in the lower Kuskokwim River subsistence fishery were harvested with either drift or set gillnets. Seven different mesh sizes were included in the drift gillnet samples (5 ½, 6, 7 ¼, 7 ½, 7 ¾, 8 and 8 ¼-inch mesh) and four mesh sizes were included in the set gillnet samples (4 ½, 8, 8 ¼ and 8 ½-inch mesh). Samples from drift and set gillnets were combined and stratified into three mesh size ranges: 6-inch or less, 7 ¼ to 7 ¾-inch, or 8-inch and greater (Tables 2 and 3). The 8-inch and greater mesh size accounted for 92.1% of the samples from the lower Kuskokwim River.

Temporal Stratification

The chinook salmon sampled in the lower Kuskokwim River were harvested in accordance with a weekly subsistence-fishing schedule during June. The subsistence fishery was closed Sunday through Tuesday and open Wednesday through Saturday. This schedule provided a frame to temporally stratify chinook salmon samples. The samples collected from the 8-inch and greater mesh size range were of adequate size to temporally stratify (n=864, Table 2). The dates used to apply this stratification were 1 through 10 June, 13 through 17 June, 20 through 23 June, and 27 through 30 June. Sample sizes from the other two mesh size ranges were not considered large enough to temporally stratify (n=38 and n=36, Table 2).

Percent Females

The overall percentage of female chinook salmon sampled from all gear types in the lower Kuskokwim River subsistence fishery was 35.1% (Table 2). The percentage of females increased with increasing mesh size: 10.5% (6-inch or less), 27.8% (7 ¼ to 7 ¾-inch) and 36.5% (8-inch or greater).

The percentage of females also showed an increase through the season. The percentage of female chinook salmon sampled from the temporally stratified 8-inch and greater mesh size range was 34.0% (1 through 10 June), 31.5% (13 through 17 June), 46.5% (20 through 23 June) and 43.0% (27 through 30 June).

Age

Samples were collected from six different age classes of chinook salmon in the lower Kuskokwim River subsistence fishery, with age-1.4 dominating (Table 2). The age composition from all gear types was age-1.4 (62.0%), age-1.3 (29.4%), age-1.2 (4.2%), age-1.5 (4.2%), age-1.1 (0.1%) and age-2.4 (0.1%). The percentage of age-1.4 chinook salmon increased with increasing mesh size: 18.4% (6-inch or less), 47.2% (7 ¼ to 7 ¾-inch) and 64.6% (8-inch and greater). Age-1.3 chinook salmon were most frequent in the 7 ¼ to 7 ¾-inch mesh (50.0%) and age-1.2 fish were most frequent in the 6 inch or less mesh size (39.5%).

The chinook salmon sampled from the lower Kuskokwim River subsistence fishery showed temporal differences in age composition when examining the four strata from the 8-inch and greater mesh size (Table 2). The percentage of age-1.4 chinook salmon increased through the season. Examining the samples collected from the 8-inch and greater mesh size, the percentage of age-1.4 chinook salmon by sample dates were: 56.9% (1 through 10 June), 63.7% (13 through 17 June), 70.1% (20 through 23 June) and 74.4% (27 through 30 June). The percentage age-1.3 chinook salmon showed a decrease temporally through the season. Examining the samples collected from the 8-inch and greater mesh size, the percentage of age-1.3 chinook salmon by sample dates were: 34.0% (1 through 10 June), 29.7% (13 through 17 June), 21.4% (20 through 23 June) and 22.1% (27 through 30 June).

Length

Length data from 903 chinook salmon sampled from the lower Kuskokwim River subsistence fishery were summarized (Table 3). The length measurements from individual fish are less precise than preferred because some of the samplers did not measure to the nearest 1 mm; some lengths were reported to the nearest 5, 10 or, in a few cases, 100 mm. Also, some lengths were reported in inches that were subsequently converted to millimeters. The sample size for length data is smaller than the sample size for age-sex data because some questionable lengths were deleted from the data set used to compile the length summary. These deleted lengths included measurements that were outside of the normal length range for that age-sex class when compared to the length frequency histogram (Figure 3). The mean lengths, by age and sex, from the chinook salmon sampled from the subsistence fishery were comparable to the mean length data collected at other Kuskokwim River projects (DuBois and Folleti unpublished report).

The mean length summary (Table 3) is arranged similar to the age and sex summary (Table 2) with data collected from the lower Kuskokwim River chinook salmon samples stratified by mesh size and temporally. No differences were observed in the mean lengths, by age and sex, among mesh size ranges or temporal strata. The mean lengths from all gear types, by age and sex, were: age-1.2 male 539 mm, age-1.2 female 530 mm, age-1.3 male 712 mm, age-1.3 female 789 mm, age-1.4 male 800 mm, age-1.4 female 839 mm, age-1.5 male 867 mm and age-1.5 female 911 mm (Table 3).

Middle Kuskokwim River

Two samplers collected ASL data from 130 chinook salmon in the middle Kuskokwim River from 13 through 23 June. Data were usable from 120 of these fish (Table 1). The samples were from chinook salmon harvested near the villages of Lower Kalskag and Aniak. Most of these samples were collected early in the run, from 13 through 16 June (n=90). The ASL data from the middle Kuskokwim River were not temporally stratified.

All chinook salmon sampled from the middle Kuskokwim River were harvested with drift and set gillnets with 8-inch mesh size (Tables 2 and 3), so the ASL data were not stratified by gear type. The percentage of female chinook salmon from the middle Kuskokwim River samples was 34.2% (Table 2). Samples included four different age classes of chinook salmon, with age-1.4 fish dominating (Table 2). The age composition was age-1.4 (48.3%), age-1.3 (36.7%), age-1.2 (8.3%) and age-1.5 (6.7%). The mean lengths, by age and sex were: age-1.2 male 552 mm, age-1.2 female 555 mm, age-1.3 male 698 mm, age-1.3 female 753 mm, age-1.4 male 792 mm, age-1.4 female 841 mm, age-1.5 male 790 mm and age-1.5 female 881 mm (Table 3).

Upper Kuskokwim River

Two samplers collected ASL data from 30 chinook salmon in the upper Kuskokwim River, and ASL data are available for 23 of these fish (Table 1). The samples were taken from chinook salmon harvested near the villages of McGrath and Nikolai from 7 through 9 July. One subsistence fisher sampled chinook salmon harvested with a 6-inch set gillnet and the MNVC technician and a staff member from ADF&G, Subsistence Division, traveled to Nikolai and sampled chinook salmon harvested with rod and reel gear.

The percentage of female chinook salmon sampled from the upper Kuskokwim River subsistence fishery was 56.5% (Table 2). Samples were collected from four different age classes, with age-1.4 fish dominating (Table 2). The age composition from chinook salmon sampled was age-1.4 (69.6%), age-1.3 (17.4%), age-1.2 (4.3%) and age-1.5 (8.7%). The mean lengths, by age and sex were: age-1.2 male 540 mm, age-1.3 male 646 mm, age-1.4 male 791 mm, age-1.4 female 792 mm, and age-1.5 female 837 mm (Table 3).

Kuskokwim River

The age-sex data collected from the lower Kuskokwim River chinook salmon subsistence fishery were pooled with the data collected from the middle and upper Kuskokwim River areas to characterize the subsistence harvest of chinook salmon for the entire Kuskokwim River. These pooled age-sex data were applied to the postseason subsistence harvest summary compiled by Subsistence Division to estimate the age-sex structure of all 73,610 chinook salmon harvested in the Kuskokwim River subsistence fishery (Table 4).

The estimated age-sex composition from the Kuskokwim River subsistence fishery was dominated by age-1.4 chinook salmon, accounting for 44,669 fish from a total harvest estimate of 73,610 (Table 5). The estimated percentages by age class were age-1.4 (60.6%), age-1.3 (29.9%), age-1.2 (4.6%), age-1.5 (4.5%), age-1.1 (0.1%) and age-2.4 (0.1%). The estimated percentage of female chinook salmon was 35.4%.

DISCUSSION

Sample Design

Salmon populations often demonstrate distinctive and dynamic trends in their ASL composition over the course of a single season, therefore it is vital that sampling designs recognize and account for both the temporal and spatial variability (Clutter and Whitesel 1956). Geiger et al. (1990) described several types of sampling methods. The following discussion describes three of these methods and their potential application for estimating the ASL composition of the subsistence chinook salmon harvest. These methods include pulse sampling, systematic sampling and grab sampling.

Pulse sampling was implemented in the Kuskokwim Area for escapement projects and commercial harvest sampling in the early 1990s to account for temporal variability in populations. Pulse samples of ASL data were collected in a small time interval periodically over the duration of the run. The sample size goal for each chinook salmon pulse sample was 210, such that the 95 percent confidence intervals for simultaneous estimates of age composition proportions would be no wider than 0.10 ($\alpha = 0.05$ and $d = 0.10$, Bromaghin 1993). A minimum of three pulse samples were recommended for chinook salmon. Pulse sampling has a greater power of detecting ASL composition changes over the course of the season than does systematic sampling or two closely spaced "grab" samples (Geiger et al. 1990). Generally, the ASL composition from each pulse sample was applied to the harvest or escapement numbers for each temporal stratum. This sampling method is not appropriate to address the objectives of the current subsistence study because the chinook harvest numbers are only available as season totals by community.

Proportional sampling is where the population is placed in some kind of order, and then every i^{th} fish in the population is sampled (Geiger et al. 1990). This method would be feasible to estimate the chinook salmon subsistence harvest composition, if the samples could be collected in a systematic fashion, because this method would address temporal changes in the ASL composition and would use the currently available harvest numbers. The difficulties associated with the proportional sampling design arise when determining a practical method to systematically sample temporally, spatially and across all gear types. As the project is currently designed, proportional sampling is not feasible.

Grab sampling is common in Alaskan fisheries research where samples are collected in a non-random manner. If the population is in nearly random order, grab sampling is similar to random sampling (Geiger et al. 1990). The grab sample design was used to sample the Kuskokwim River subsistence chinook fishery during 2001. The investigators desired results that would estimate the ASL composition of the subsistence chinook harvest by geographic section, and lead to analytical comparisons among different subgroups of the population, such as changes in ASL composition that could be attributed to temporal, spatial or gear selectivity. The investigators believed that with enough samples, the statisticians would be able to make valid analytical comparisons. However, a limited sample dictates that only descriptive comparisons are available. Systematic research into the sample design, which will accomplish the desired objectives, should be undertaken. Such elements of the sample design that merit further consideration are sampling units and size, degree of precision desired, organization of fieldwork, summary and analysis of those data.

Lower Kuskokwim River

The 938 aged chinook samples collected from the lower Kuskokwim River were adequate for estimating the ASL composition of the subsistence chinook harvest from the lower Kuskokwim

River (Bromaghin 1993). However, the lower, middle and upper Kuskokwim River samples were combined and the age-sex composition for the lower Kuskokwim River subsistence harvest is presented for informational purposes only (Table 5). An estimate of 63,605 chinook salmon were harvested during the 2001 subsistence fishery from the lower Kuskokwim River study area (Table 4). The sample size represents 1.6% of the harvest. The sample size goal for 2001 was 3,000, and had this goal been attained, the samples would have represented 4.7% of the population.

The temporal change in age composition observed with the 8-inch and larger mesh size range from the lower Kuskokwim River samples has also been observed in the commercial and escapement samples from Kuskokwim River projects (DuBois and Molyneaux 2000). Typically, the percentage of older chinook salmon increases through the season. The increased percentage of females through the season is also typically observed in the commercial and escapement samples. A noticeable difference in the percentage of female chinook salmon is apparent between the first and second halves of the temporally stratified samples collected from the 8-inch and greater mesh size range, but a stepwise increase in percentage of females through the season, by stratum, is not observed (Table 2). One possible reason for the percentage of females not increasing through the season may be because of the selectivity of gillnets using 8-inch and larger mesh. Larger mesh sizes will select for larger sized fish that tend to be a higher proportion of females.

Middle Kuskokwim River

The 120 aged chinook samples collected from the middle Kuskokwim River were not adequate for estimating the ASL composition of the subsistence chinook harvest from that area. The sample size represents 2.0% of the 6,346 chinook salmon harvested from the middle Kuskokwim River study area in 2001(Table 4). The sample size goal for 2001 was 1,500, and had this goal been attained, the samples would have represented 23.6% of the population, which in retrospect was an unrealistic expectation.

One of the reasons why so few chinook salmon were sampled was that a boat was not always available to the KNA technicians to travel to fish camps for soliciting samplers. A boat for this purpose did arrive, but not until after much of the subsistence chinook salmon harvest was completed. Another factor contributing to the low sample size was that many subsistence fishers were not interested in collecting ASL data. Some of these fishers expressed discontent regarding the fishing schedule that was implemented in 2001.

Samples were only collected from drift and set gillnets hung with 8-inch mesh in the middle Kuskokwim River subsistence fishery. This may not be an adequate representation of the gear types used in the fishery because only two fishers were sampled, representing two gear types and one mesh size. Data from the subsistence harvest summary in 2000 reported that 42 of 254 households contacted from the middle Kuskokwim River area used rod and reel gear (Burkey et al. 2001). Rod and reel gear was probably used in 2001 therefore; gear types sampled were not typical of the gear types used in the subsistence fishery.

The age composition from the chinook salmon samples collected from the middle Kuskokwim River is probably not representative of the entire chinook salmon harvest from this area. Seventy percent of the samples were collected from 13 through 16 June, whereas the central 50 percent of the harvest from that area occurs between 14 and 23 June (Mike Coffing personal communication, subsistence catch timing Lower Kalskag to Chuathbaluk, 1989-1999). This time frame sampled corresponds with the early part of the chinook salmon run passing through the middle Kuskokwim River. The age composition from these samples is consistent with the expected age composition from early run chinook samples, a higher proportion of younger fish and a lower proportion of older fish (DuBois and Molyneaux 2000). Comparing the age proportions, between the season total of the lower and middle Kuskokwim River, from combined samples collected with eight-inch gear and larger mesh size, the middle Kuskokwim River samples exhibit higher proportions of younger fish (age-1.2 and age-1.3 chinook salmon) and a lower proportion of older fish (age-1.4 chinook salmon). For example, the percentages of age-1.2 chinook salmon were 8.3 from the middle Kuskokwim River and 2.7 from the lower Kuskokwim River, a difference of positive 5.6; age-1.3 chinook salmon percentages were 36.7 from the middle Kuskokwim River and 28.1 from the lower Kuskokwim River, a difference of positive 8.6; and age-1.4 chinook salmon percentages were 48.3 from the middle Kuskokwim River and 64.6 from the lower Kuskokwim River, a difference of negative 16.3 (Table 2). Granted, these comparisons are non-statistical, but they do support the premise that the age composition from the middle Kuskokwim River samples is not similar to the lower Kuskokwim River samples. One possible reason for this dissimilarity is that samples were not collected systematically throughout the harvest as it passed the middle Kuskokwim River. When samples are not collected systematically throughout the harvest, assessing the true age composition is problematical.

Upper Kuskokwim River

The 23 aged chinook samples collected from the upper Kuskokwim River were inadequate for estimating the ASL composition of the subsistence chinook harvest from this geographic section. An estimated 657 chinook salmon were harvested during the 2001 subsistence fishery from the villages in the upper Kuskokwim River geographic section (Table 4). The preseason sample size goal of 1,000 was not attained, and is clearly unrealistically high.

The nature of the upper Kuskokwim River area subsistence chinook fishery makes obtaining inseason ASL data difficult. Unlike the subsistence fisheries in the middle and lower Kuskokwim River, the number of salmon typically harvested by upper Kuskokwim River households is relatively low and the total number of subsistence fishers is relatively small. Small numbers of chinook salmon may be processed quickly, leaving little time for the technician to sample the harvest before processing. Also, many of the subsistence fishers harvest chinook salmon in tributaries some distance from their home and processing may occur at the harvest site or shortly upon arrival in their village.

Other factors leading to lower sample numbers were that more employment opportunities were available for upper Kuskokwim River village residents and some usual subsistence fishers may have been unable to fish because of work schedules. The weekly subsistence-fishing schedule may also have decreased participation in subsistence fishing. There was also inadequate follow-up by the MNVC technician with some subsistence fishers who were issued sampling kits. Staff changes at MNVC resulted in the MNVC technician working with little direct supervision

Kuskokwim River

The temporally stratified age compositions for the 8-inch and larger mesh size range in the lower Kuskokwim River cannot be applied to the Kuskokwim River subsistence harvest data because the harvest data are only available as a season total, not stratified temporally or by gear type. For this reason, all mesh sizes and gear types from the Kuskokwim River samples were pooled. The lower Kuskokwim River age-sex compositions from the temporally stratified 8-inch and larger mesh size range, and strata by mesh size range were presented for informative purposes only.

The decision to pool the age-sex samples collected from the lower, middle and upper Kuskokwim River was made after consultation with the ADF&G AYK Regional Biometrician, AYK Regional Research Coordinator, and the Kuskokwim Area Research Biologist; subjectively, after examining sample sizes and distribution and gear types sampled. The samples from the lower, middle and upper Kuskokwim River were combined because the sample sizes collected from the middle and upper Kuskokwim River areas were judged to be inadequate to characterize these subsistence chinook salmon harvests. By combining all sample data the assumption was made that samples were collected through the season, samples were collected in proportion to the harvest through time and samples were collected in proportion to the gear types employed. Therefore, the age-sex of the combined data represents the age-sex of the chinook salmon harvested in the Kuskokwim River subsistence fishery. Some of these assumptions may be invalid and further research could be undertaken to test these assumptions. One challenge in testing these assumptions is harvest data stratified by gear type or temporally are not available from Subsistence Division. Not pooling the samples from the lower, middle and upper Kuskokwim River would have allowed only the age-sex of the lower Kuskokwim River chinook harvest to be characterized.

The combining of all samples from the lower, middle and upper Kuskokwim River areas may be the most viable way to describe the age-sex structure of the Kuskokwim River subsistence chinook harvest when inadequate sample sizes are available to independently describe the harvest from each geographic section. As noted in the objectives, the ASL samples from each project were to estimate the subsistence chinook salmon harvest from each projects' area. Not stated in the objectives, but implied in the introduction, was for each of these three independent estimates of subsistence harvested ASL compostion to be combined to estimate the ASL composition of the entire Kuskokwim River subsistence chinook salmon harvest.

The length frequency histogram from all of the chinook salmon samples collected in the Kuskokwim River subsistence fishery is shown in Figure 3. Comparing this histogram with similar histograms from other Kuskokwim River projects confirms that the age-sex by length for the subsistence chinook samples is similar to age-sex by length from other projects (DuBois and Folletti unpublished report). Figure 3 was used when evaluating ASL data that were outside of the typical range. Some lengths were deleted when compiling the length summary (Table 3) because the length measurement appeared to be incorrect for the particular age-sex data. All available age-sex data were used to compile the age summary (Table 2).

CONCLUSIONS AND RECOMMENDATIONS

Lower Kuskokwim River

The samples collected from the lower Kuskokwim River were adequate for estimating the ASL composition of the subsistence chinook harvest from that portion of the river. The lower Kuskokwim River samples showed differences in age-sex composition temporally, as well as by gillnet mesh size.

The chinook salmon sampling program from the lower Kuskokwim River was a success in 2001 and with continued participation from existing samplers; the program should be a success in 2002. The sample size goal from the lower Kuskokwim River subsistence chinook harvest will remain at 3,000 fish. Attaining this sample size would be adequate to characterize the ASL composition as well as discern temporal, spatial or gear selectivity differences in ASL composition. To achieve this sampling goal will require increased participation from samplers and continued diligent oversight by the ONC technicians and ADF&G staff. ADF&G and ONC will need to identify, train and recruit new samplers as well as retain qualified samplers from 2001. ADF&G staff will be selective in distributing sampling kits and focus efforts on training individuals that will become successful samplers.

Middle Kuskokwim River

The middle Kuskokwim River ASL samples were not adequate for estimating the ASL composition of the subsistence chinook harvest from that geographic section because of a small sample size, only one gillnet mesh size was sampled and the samples were not collected throughout the harvest. The age composition from the chinook salmon sampled is probably not representative of the age composition of the middle Kuskokwim River subsistence chinook harvest.

The sample size goal for the middle Kuskokwim River subsistence chinook harvest should be reduced to 750. Attaining this sample size in 2001 would have sampled 11.8% of the subsistence chinook salmon harvested in the middle Kuskokwim River area and would be adequate to characterize the ASL composition. To achieve this sampling goal will require increased participation from samplers, sampling from more gear types and sampling throughout the duration of the harvest. The subsistence fishers in the middle Kuskokwim area need to realize the importance of collecting ASL data. Several key fishing households that harvest substantial numbers of chinook salmon were not interested in sampling their harvest. To provide greater incentive for samplers to participate, the payment for samples collected should be increased. The KNA technicians will need to be more diligent in follow-up visits with subsistence fishers who are issued sampling kits. The KNA and ADF&G staff will need to provide more oversight of the technicians to ensure that sample goals are met.

Upper Kuskokwim River

Adequate sample sizes to characterize the upper Kuskokwim River subsistence chinook harvest will be difficult to obtain because of low harvest rates and few subsistence fishers. Subsistence fishers should be contacted well before subsistence fishing begins and have a way to contact the MNVC technician inseason. The MNVC technician should identify, solicit and train ASL samplers in the communities or arrange to sample their harvest. A leased boat or chartered aircraft could transport the MNVC technician to villages or tributary streams where subsistence fishing occurs. Subsistence fishers should have a way to contact the MNVC technician when they have questions or when they have chinook salmon available for the MNVC technician to sample. Staff from MNVC should provide better oversight, supervision and support of this project. An ADF&G Fisheries Biologist, stationed in Takotna, as well as additional ADF&G staff will work closely with the MNVC technician towards achieving the project objective.

The sample size goal from the upper Kuskokwim River subsistence chinook harvest should be reduced to 300. Attaining this sample size in 2001 would have sampled 45.4% of the subsistence chinook salmon harvested in the upper Kuskokwim River area, but is probably still overly optimistic. To provide greater incentive for samplers to participate, the payment for samples collected should be increased.

Kuskokwim River

The sample design of each project will need to be reevaluated if each project objective is not consistently attained. The sampling design that will capture the "true" population structure of the Kuskokwim River chinook salmon subsistence harvest should be pursued. If inadequate sample sizes from the middle and upper Kuskokwim River subsistence chinook salmon harvest preclude estimating the population structure from those areas, a different sampling design needs to be developed. A sampling design that applies ASL sample data collected from only the lower Kuskokwim River, to estimate the population structure of the Kuskokwim River chinook salmon subsistence harvest, may be one design to consider. FOSM and ADF&G will need to identify cost, time and methodology constraints to achieve appropriate solutions that will characterize the "true" population structure of the Kuskokwim River chinook salmon subsistence harvest. These solutions may require additional proposals, labor, data collecting, funding, analyzing and reporting.

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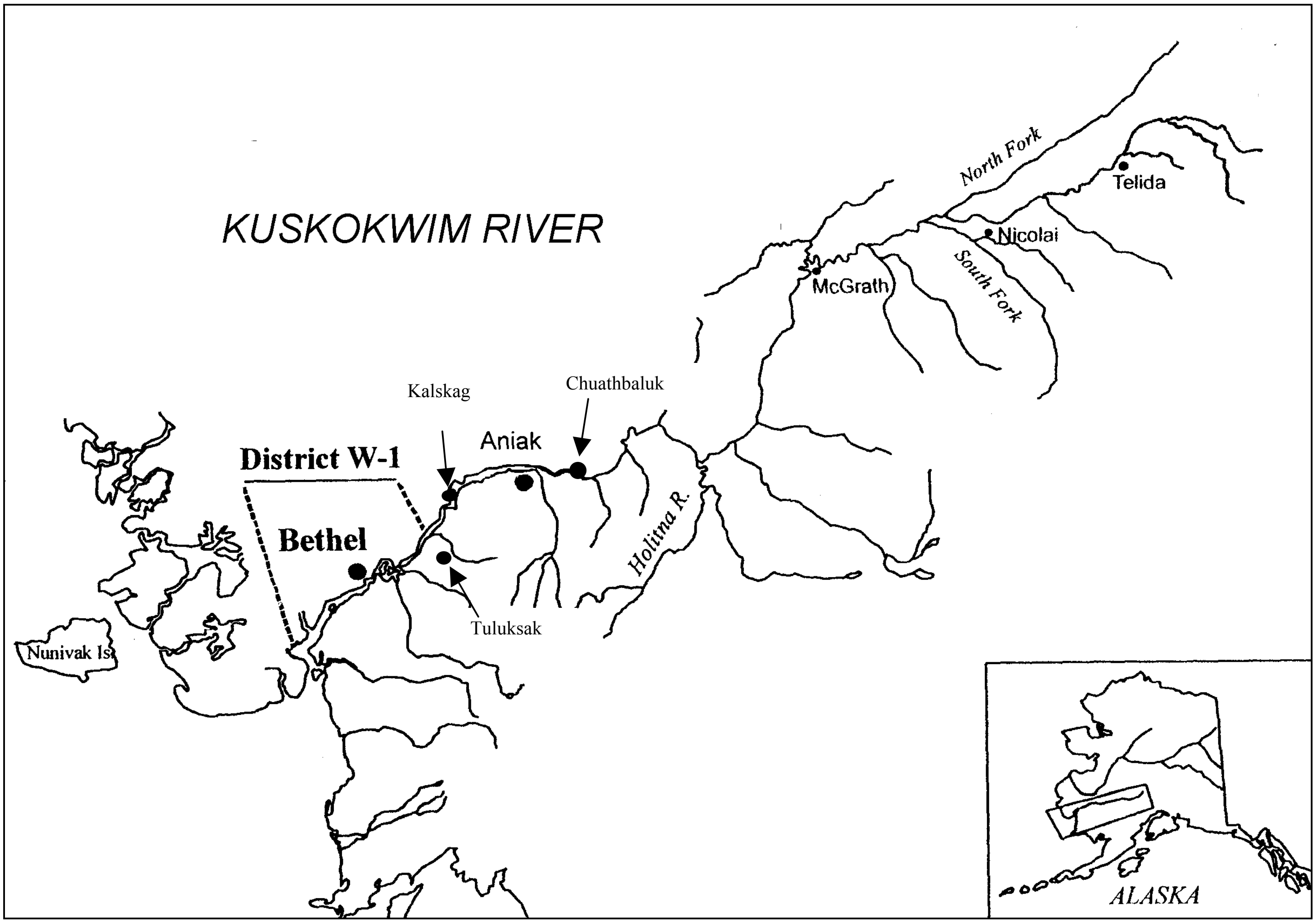


Figure 1. Map of Kuskokwim River.

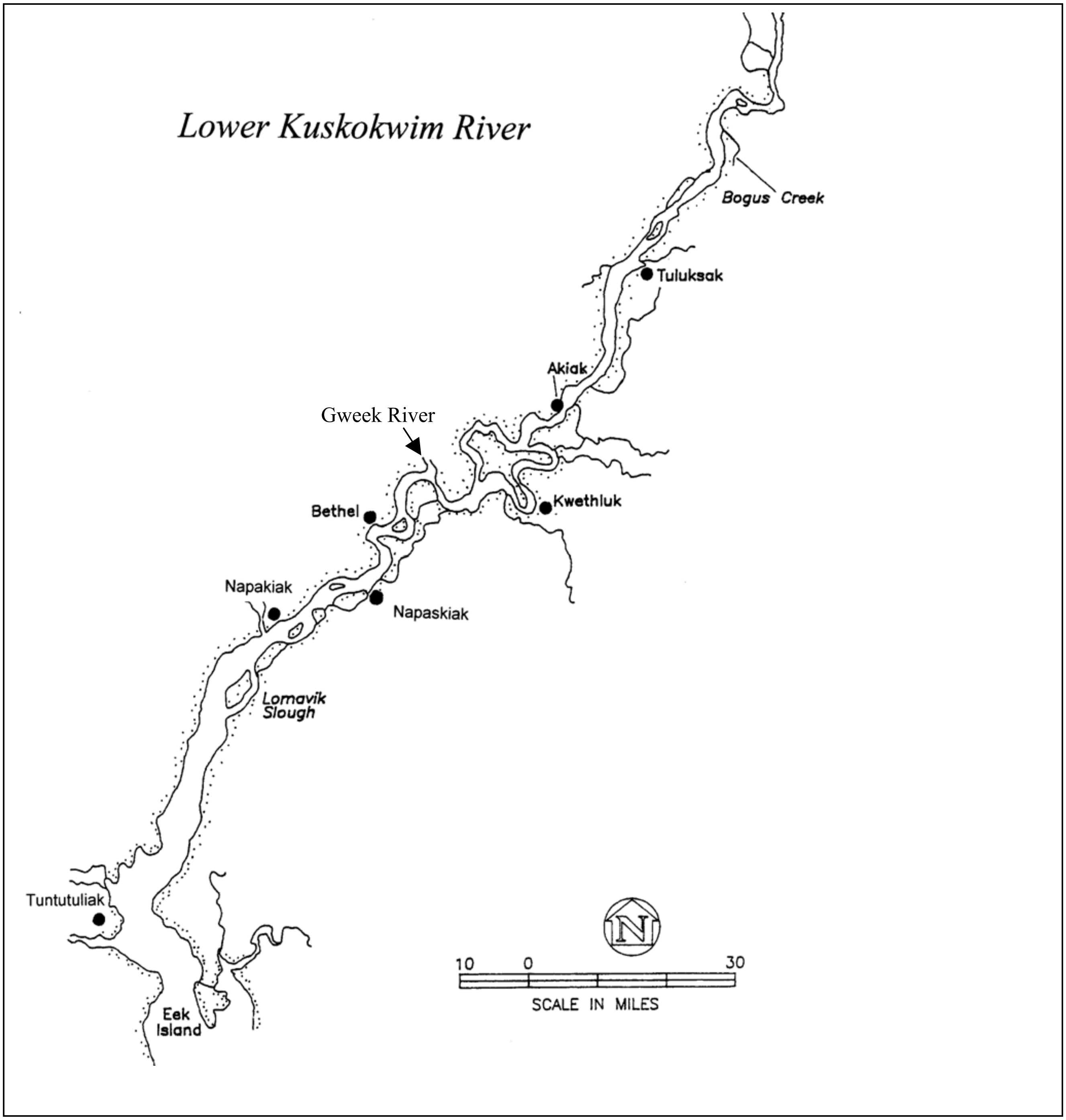
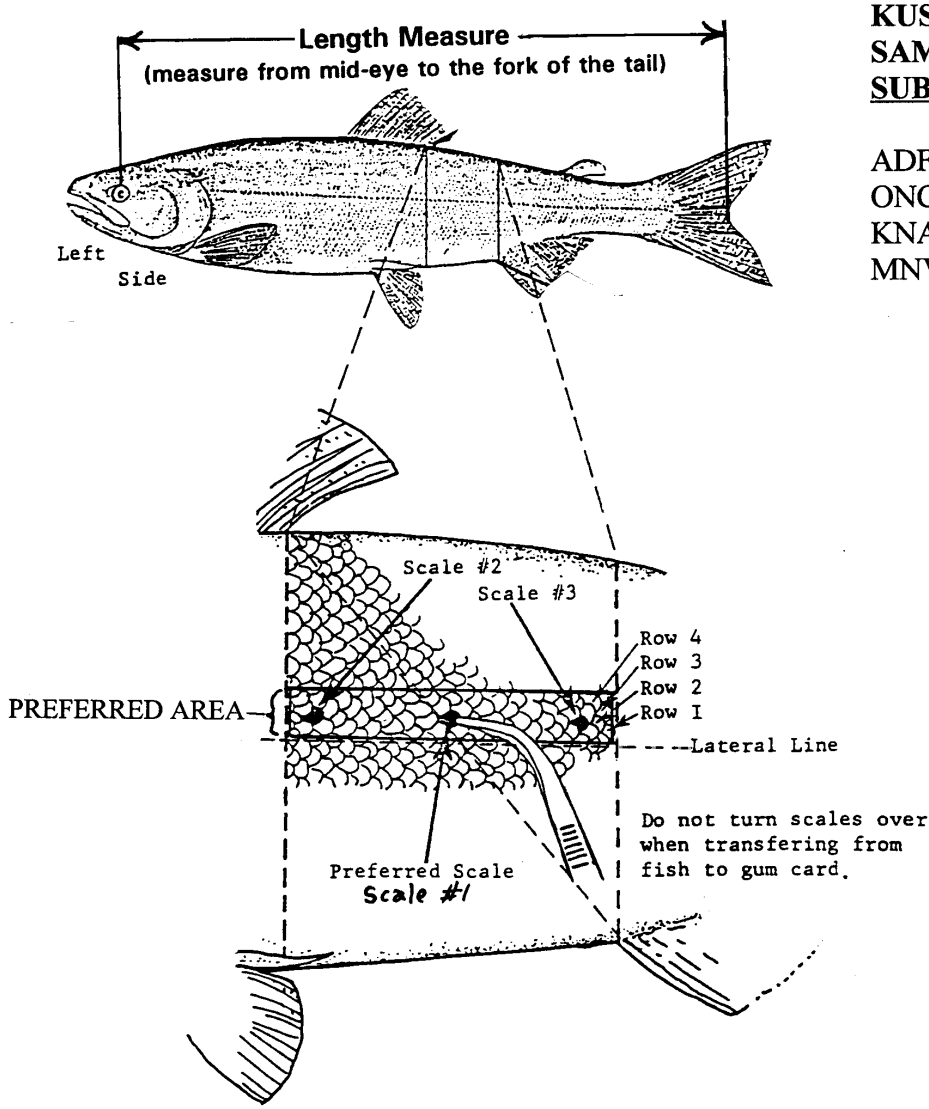


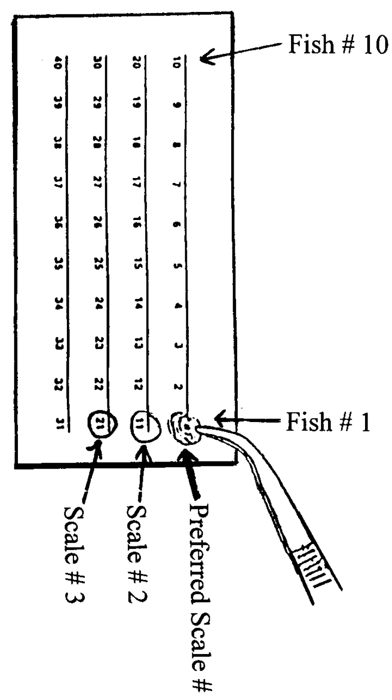
Figure 2. Map of lower Kuskokwim River.

Appendix A.1. Instruction sheet for ASL sampling of chinook salmon.



KUSKOKWIM RIVER
SAMPLING PROGRAM FOR
<u>SUBSISTENCE KING SALMON</u>

ADF&G (Bethel) 543-2433
ONC (Bethel) 543-2608
KNA (Aniak) 675-4384
MNVC (McGrath) 524-3023



Age-Sex-Length Sampling Instructions

1) Position king salmon left side up.
2) Take preferred scale #1 located two rows above the lateral line and intersecting a diagonal line from the back of the dorsal fin to the front of the anal fin.
3) Clean scale by removing slime.
4) Place scale directly over number on gum card. Be careful to keep scale right side up and mount scale in same orientation.
5) Repeat above steps for scales # 2 and # 3 (see picture).
6) Measure length (mm) from mid-eye to fork of tail.
7) Cut fish belly and determine sex.

Payment requires the following information for each king salmon:

1) Three readable scales from each fish.
2) Sex of each fish.
3) Length of each fish.
4) Gear type and mesh size.
5) Date of capture.
6) Location of capture.
7) Your name on data form and scale card.